Factsheet Borgna-Converter

1. Theory of Operation

Borgna-Converters consist of two sub-converters (buck, boost or buck-boost) whose chopper voltages are being coupled with a small capacitor. The power switches of both sub-converters turn on simultaneously. As Borgna-Converters operate in discontinuous current mode, the switches turn on at zero-current. As soon as the desired peak inductor current is reached, the switches are being turned off again, but with a slight delay between the sub converters. This allows the inductor current to be redirected into the coupling capacitor, which results in a low-gradient switching slope. As a result, the power switches are turned off at nearly zero-voltage. Due to this zero-current / zero-voltage switching, switching losses and electromagnetic disturbances are being reduced considerably. The following two figures demonstrate the theory of operation with help of the example of the Borgna-Boost-Converter.

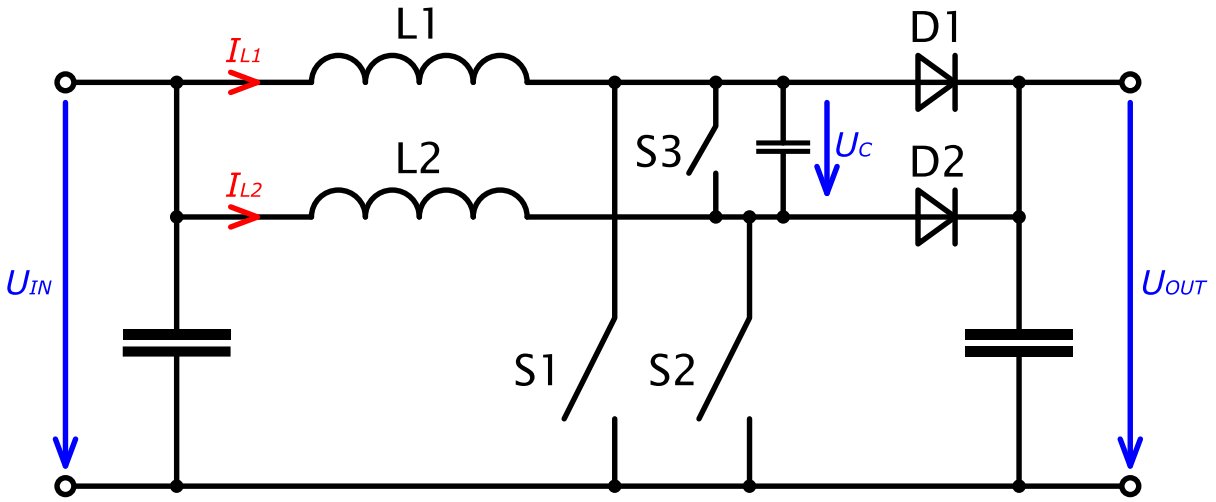

Figure 1: Topology of the Borgna-Boost Converter

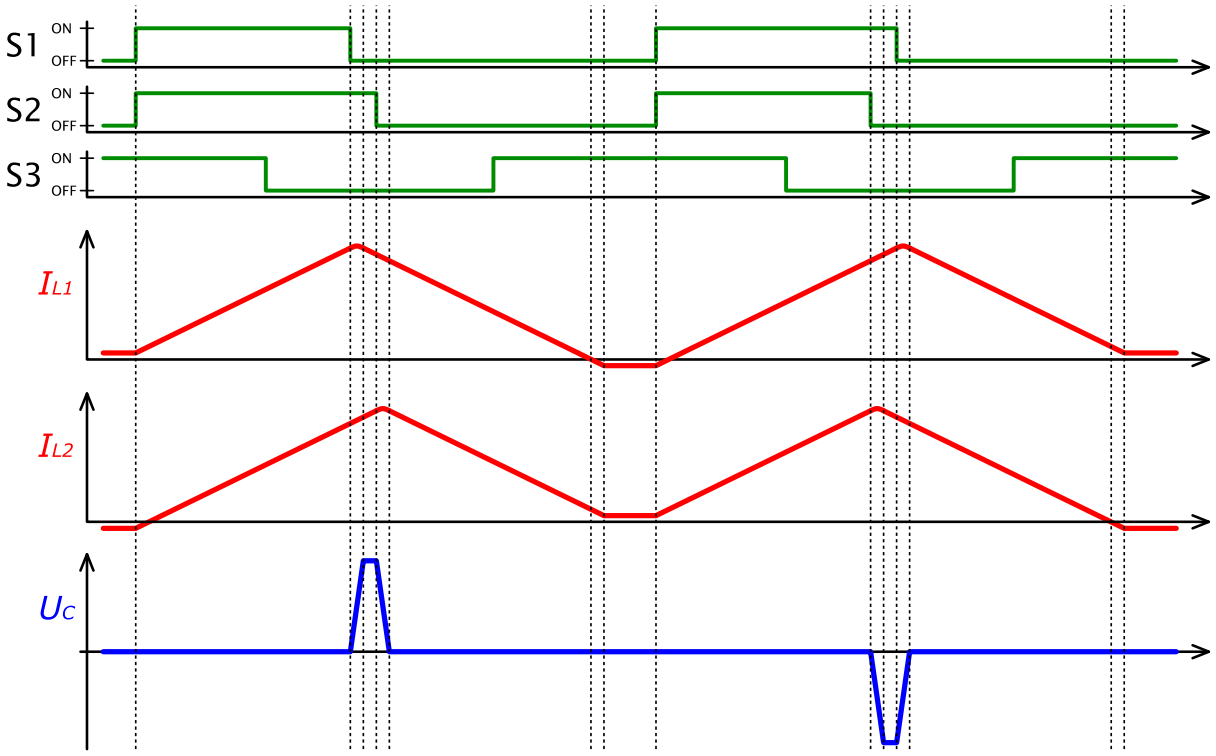

Figure 2: Timing diagram of the Borgna-Boost-Converter.

2. Possible topologies

The principle described under section 1 can be transferred directly to the buck- and the buck-boost-converter. By combining the boost and the buck converter, a bidirectional converter (a.k.a. active or synchronous rectifier) can be realised. Furthermore, by modulating the output voltage, Borgna-Converters can be used to generate ac waveforms, paving the way to a multitude of inverter topologies. As an example, by use of three bidirectional converters, a 3-phase inverter can be realized (Figure 3).

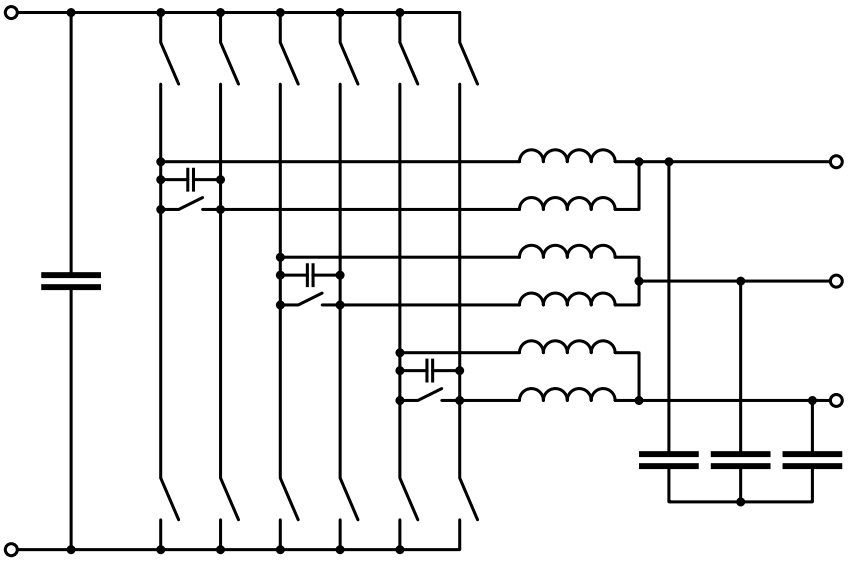

Figure 3: 3-Phase Borgna-Converter

3. Prototype

We designed, realised and tested a bidirectional Borgna-Converter, which is shown in Figure 4.

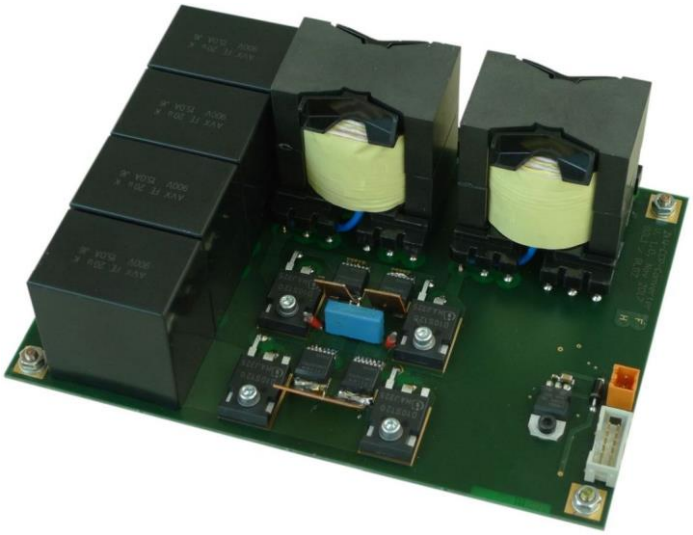

Figure 4: 2kW-Prototype Borgna-Converter

Technical Data

Nominal Power:	2kW
Voltage (low side):	400V
Voltage (high side):	800V
Switching frequency:	50kHz
Peak efficiency[1)]:	> 99.3%
Conducted Noise[2)]:	< 80dBµV
PCB-Dimensions:	184 x 128mm

1) Buck-Mode at $P_{OUT} = 1512\text{W}$
2) 0.15-30MHz without any filtering

Further Information
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